Nanoprobing electrons in quantum structures

- imaging quantized states of semiconductor electrons -

16

NTT

Motivation

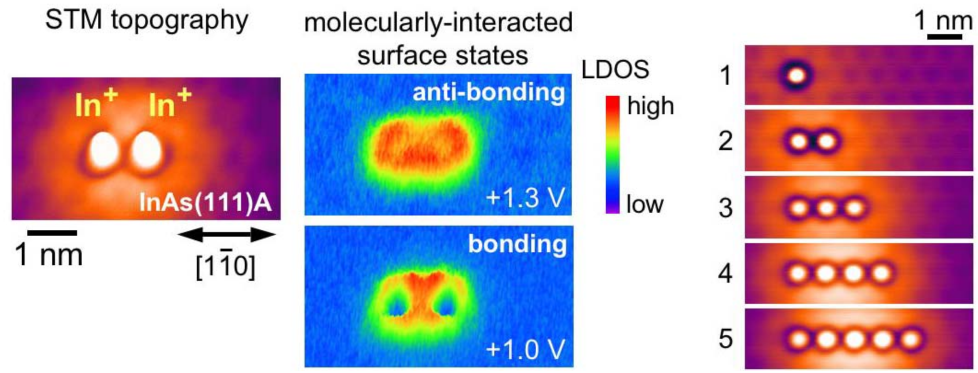
Future information technologies will be realized by nanometer-scale (1 nm = 10^{-9} m) semiconductor devices. In such devices, electron behavior is dominated by the quantum mechanics. Thus, real-space understanding and control of the nanometer-scale physics is very important to develop high-performance quantum devices through observing electron behavior directly in the nanostructures.

Originality

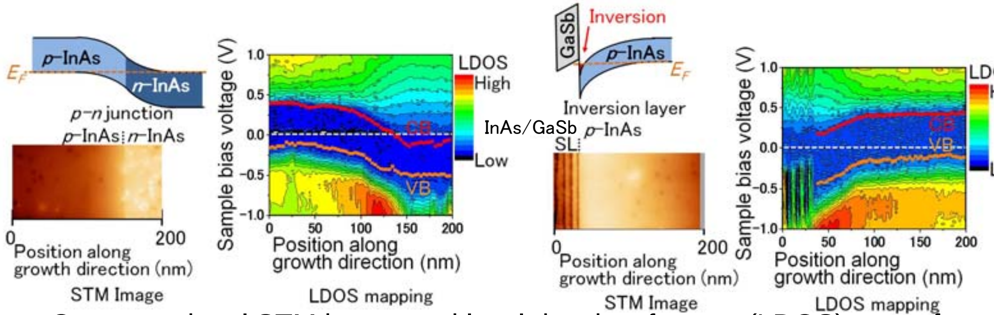
Using scanning tunneling microscope (STM) at low-temperature, we succeeded to perform atom manipulation and *in-situ* characterization on the semiconductor surface. Coherently coupled electronic states of interacting adatoms was imaged. At the cross-section of semiconductor devices, such as the *p-n* junction and inversion layer, nanometer-scale energy band profiles were characterized. Semiconductor electronic states can be understood directly with controlling them at atomic scale.

Impact

This technology will contribute to further understanding and control of quantum mechanical phenomena of electrons and holes in low-dimensional semiconductor structures designed for quantum devices and quantum computers.



Due to adjacent positioning of ionized In atoms on the InAs(111)A surface, molecularly coupled states were observed. One-by-one atom manipulation at the surface makes it possible to control semiconductor quantum states.
This work is achieved in collaboration with Paul-Drude-Institut (Germany).



Cross-sectional STM image and local density of states (LDOS) map of *p-n* junction (left) and inversion layer (right) in InAs.

Energy band structures of *p-n* junction and inversion layer in semiconductor devices can be imaged with nanometer scale resolution. CB and VB are experimentally obtained conduction and valence band edges.

サイエンスプラザ2009 ナノサイエンスが拓く量子の世界

NTT Basic Research Laboratories

Contact: Kiyoshi Kanisawa kani@will.brl.ntt.co.jp
Kyoichi Suzuki kyoichi@will.brl.ntt.co.jp